Preliminary observations on the natural resistance of sixty-nine Species of Indian timber to Marine Borer attack at Bombay

BY

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(*With a text-figure*)

INTRODUCTION

Destruction of timber constructions in sea water by marine wood borers being well known and universal in occurrence, problems pertaining to protection of timber in marine environments have engaged the attention of scientists from very early times. It is known that certain species of timber possess a high degree of resistance to the destructive activity of wood borers, though none of them has absolute immunity to their attack. Several investigators have studied the natural durability of different kinds of timber in a bid to select the right type for marine constructions (Atwood & Johnson 1924 ; and Wangaard 1953, in America ; Gonggrijp 1932 ; Spoon & Loosjes 1946 ; Bavandamm 1948, 1949 ; and Roch 1955, in Europe ; Wilson 1941, and Johnson & Moore 1950, in Australia ; Thomas 1933, in Malaya ; Edmondson 1955, in Hawaii Islands ; Bianchi 1932 and 1934, in Indonesia ; Scott 1932, in Burma ; and Fforde 1931, in Africa). In India some of the earliest studies on this subject are those of Troup (1909), Messent P. Glynn (1920), Pearson (1932) and Howard (1948). Observations of Nair (1956) in Madras harbour and Kayamkulam backwaters (Kerala), of Nagabhushanam (1960) in Visakhapatnam harbour and of Balasubramanyam & Menon (1963) in Cochin harbour are recent contributions in this field.

The durability of timber varies considerably in different localities on account of variations in species of borers and their abundance. Salinity and temperature usually act as limiting factors on the activity and distribution of these pests and the rapid reaction of borers, especially shipworms, to even slight change in conditions, results in varying performance of a timber species in different localities. It is, therefore, necessary to study the life of the same species of timber in different regions.

The work of Nair (1956) and of Balasubramanyam & Menon (1963) include only very few species of timber and that of Nagabhushanam (1960) is confined to the east coast of India. The present paper gives a preliminary report on the resistance of sixty-nine species of Indian timber to marine borers in Bombay waters.

Material and Method

Panels of sixty-nine species of timber, studied in the present work, were received from the Forest Research Institute & Colleges, Dehra Dun. These panels, 30 cm.×3·8 cm.×3·8 cm. were arranged as 'ladders', each containing 10 panels, by tying them with 5 mm. diameter nylon rope threaded through holes bored at each end (Fig. 1). The distance between two adjacent panels was about 7·5 cm. Seven such 'ladders' (one of them containing 11 panels as *Bombax ceiba* Linn. and *Pinus roxburghii* Sargent have been procured from two growing areas, making the total number of panels 71) were firmly secured to a pair of long slotted iron bars. The whole set was then suspended on sufficient length of mild steel chain so that the panels were always five feet below the extreme low tide level. The frame was properly weighted so as to anchor it in position.

The test site—the Burmah-Shell Jetty at Trombay—provides typical marine conditions which are influenced only by the south-west monsoon. Intensive borer activity and heavy settlement of foulers have been noticed in this place, both marked by seasonal variations. The test panels were immersed on 15th March 1967, and were removed to the laboratory for final inspection and assessment of destruction on 16th December 1967, after a period of nine months' continuous submergence. No periodic examination of the panels was made during the course of the studies. However, the panels were taken out and scraped clean of the foulers at intervals of two months so as to allow access to borer larvae to the timber surface. This was actually found necessary because of the heavy settlement of barnacles, completely covering the panels and giving them a sort of mechanical protection from borer infestation. During final assessment in the laboratory the panels were cleaned well and the number of borer holes was carefully counted and recorded. (In cases where more than 300 borers could be counted, the number has been expressed as 'numerous'). The panels were later cut open into halves and the extent of internal destruction was roughly assessed by visual examination.

Results

The important borers encountered during the present study are *Bankia campanellata* Moll & Roch, *Lyrodus pedicellatus* Quatrefages, *Bankia rochi* Moll and *Martesia striata* Linnaeus. Of these *B. rochi*

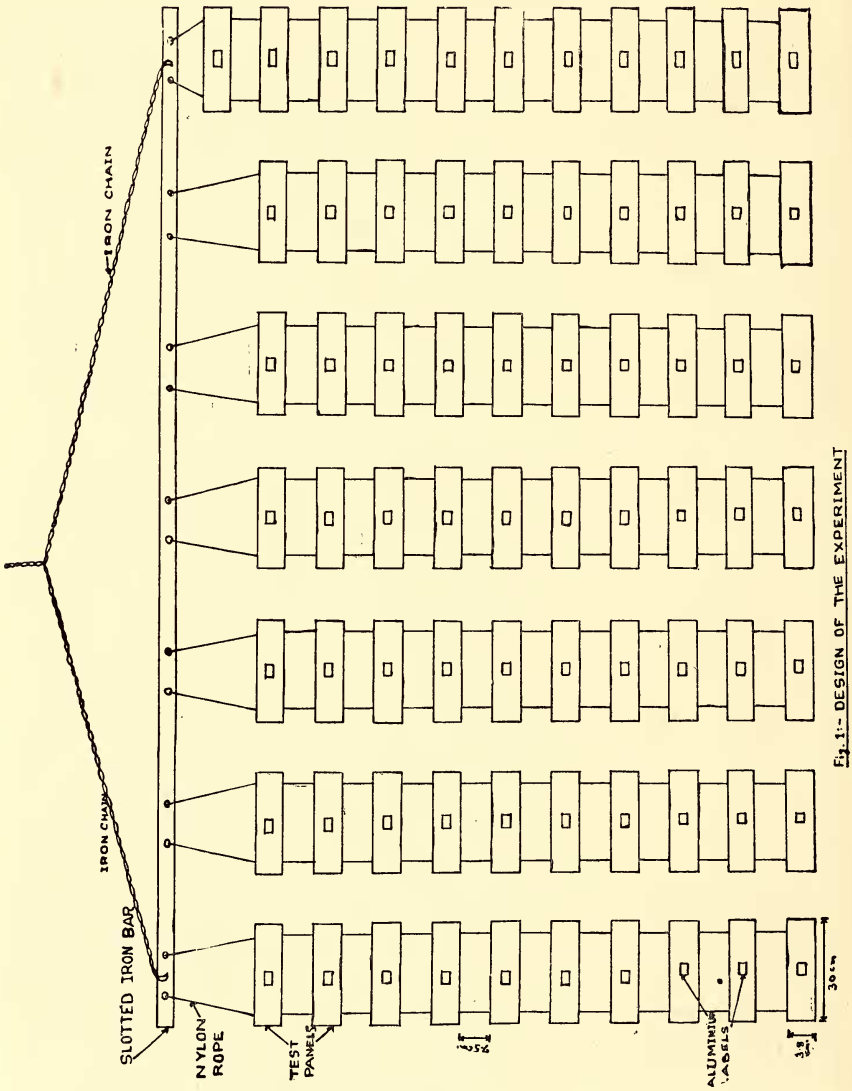

Fig. 1:- DESIGN OF THE EXPERIMENT

and *M. striata* were found to settle only in very small numbers. One specimen of *Nausitora hedleyi* Schepman was also collected from a panel of *Albizzia odoratissima* Benth.

Data on incidence of borers on different panels, the extent of damage caused to them expressed in percentage, localities from where the panels were procured and the common names of timber species are given in Table 1. The table shows that while none of the sixty-nine species escaped attack of borers, 21 species suffered destruction below 20%, 11 of them between 21 to 50% and the remaining 27 species over 50% destruction. Family-wise distribution of resistant species of timber is given in Table 2.

Discussion and Summary

1. Observations on natural durability of sixty-nine species of Indian timber, belonging to 30 families are included in this report. Even though the duration of observation may be insufficient for a definite evaluation of the life of many species, the studies enable elimination of non-resistant varieties and screening out promising ones, worthy of consideration for further studies. A scrutiny of Table 2 reveals that *Moraceae* and *Leguminosae* contain some species which are highly resistant to borer attack.

2. The durability of any untreated panel is very much influenced by the time of the year at which it is exposed to borer-attack. In other words, it depends upon seasonal variations in the intensity of borers available to carry out destruction. Earlier studies have revealed that in the present locality the peak settlement of borers and the consequent destruction of a panel are maximum during July-August and a panel of *Mangifera indica* Linnaeus, immersed during this short period alone, suffered 58% destruction (Santhakumaran, unpublished). Hence it is justifiable to believe that, although the duration of the experiment was nine months starting from March, the non-durable species might have suffered heavy destruction even within a much earlier period, that is to say, months before the study was terminated in December. Moreover, the highly vulnerable species had only few, small, live specimens in the burrows showing that the early settlers had already perished when the timber was exhausted due to overcrowding.

3. A scrutiny of the data, given in Table 1, indicates that there is no definite correlation between the number of borer holes and the internal damage caused to the timber panels. For example, although the species of *Artocarpus lakoocha* Roxb. (272 borers), *Hopea parviflora* Bedd. (numerous) and *Lannea coromandelica* (Houtt.) Merr. (=*Odina wodier* Roxb., numerous) have harboured large number of borers, the destruction of timber is only about 2%, 5%, and 18% respectively. On

TABLE 1

PARTICULARS OF TIMBER SPECIES AND EXTENT OF DESTRUCTION CAUSED BY BORERS IN PRELIMINARY TRIALS AT BOMBAY

No.	Timber species	Family	Trade name	State from which procured	Borer entry holes on panels		Extent of damage %	Rem
					Ship worms	*Martesia*		
1.	*Madhuca indica* (Gmel.) (=*Bassia latifolia* Roxb.)	Sapotaceae	Mahua	Orissa	151	3	1·0	Many pits
2.	*Terminalia paniculata* Roth.	Combretaceae	Kindal	Tamil Nadu	83	2	1·0	
3.	*Artocarpus lakoocha* Roxb.	Moraceae	Lakooch or Barhal	West Bengal	272	3	2·0	Pits only
4.	*Artocarpus heterophyllus* Lamk. (=*Artocarpus integrifolia* L.f.)	-do-	Kathal	Tamil Nadu	160	1	2·0	Pits only
5.	*Kingiodendron pinnatum* (Roxb.) Harms. (=*Hardwickia binata* Roxb.)	Leguminosae	Piney	-do-	72	5	2·0	
6.	*Pterocarpus marsupium* Roxb.	-do-	Bijasal	-do-	145	1	2·0	Pits only
7.	*Xylia xylocarpa* Taub.	-do-	Irul	-do-	98	Nil	2·0	
8.	*Steriospermum chelonoides* DC.	Bignoniaceae	Padri	West Bengal	85	2	4·0	
9.	*Hopea parviflora* Bedd.	Dipterocarpaceae	Hopea	Coorg	Numerous	Nil	5·0	Pits only
10.	*Borassus flabellifer* Linn.	Palmae	Palmyra Palm or Tari	Bihar	103	2	7·0	
11.	*Lagerstroemia parviflora* Roxb.	Lythraceae	Lendi	Orissa	152	4	8·0	Pits only
12.	*Pterocarpus dalbergioides* Roxb.	Leguminosae	Padauk	Andaman	190	10	8·0	
13.	*Tectona grandis* Linn. f.	Verbenaceae	Teak	Tamil Nadu	181	6	11·0	Superficial small tunnels
14.	*Holoptelea integrifolia* Planch.	Ulmaceae	Kanju	Bihar	203	7	11·0	Many pits

15.	*Dalbergia latifolia* Roxb.	Leguminosae	Rosewood	Bombay	115	8	12·0	
16.	*Calophyllum elatum* Bedd. (=*Calophyllum tomentosum* Wt.)	Guttiferae	Poon	Tamil Nadu	79	6	13·0	
17.	*Artocarpus* sp.	Moraceae		-do-	103	7	13·0	
18.	*Schleichera oleosa* Oken. (=*Schleichera trijuga* Willd.)	Sapindaceae	Kusum	Uttar Pradesh	96	3	15·0	
19.	*Lannea coromandelica* (Houtt.) Merr. (=*Odina wodier* Roxb.)	Anacardiaceae	Jhingan	Bombay	Numerous	Nil	18·0	Tunnels at right angle to the grain
20.	*Eucalyptus* sp.	Myrtaceae		Uttar Pradesh	173	5	18·0	
21.	*Tetrameles nudiflora* R. Br.	Datiscaceae	Maina	Andaman	163	9	20·0	One of the ends of the panel worn out due to abrasion
22.	*Aphanamixis polystachya* (Wall.) Parker (=*Amoora rohituka* W. & A.)	Meliaceae	Pitraj	Tripura	254	1	22·0	
23.	*Amoora wallichi* King	-do-	Amari	West Bengal	53	3	23·0	One huge tunnel
24.	*Dipterocarpus* sp.	Dipterocarpaceae		Mysore	183	5	27·0	One end severely damaged
25.	*Terminalia chebula* Retz.	Combretaceae	Myrabolan or Hararh	West Bengal	Numerous	2	30·0	Numerous small pits
26.	*Hopea* sp.	Dipterocarpaceae		Tamil Nadu	87	2	31·0	
27.	*Artocarpus hirsuta* Lamk.	Moraceae	Aini	Coorg	171	4	33·0	
28.	*Bridelia retusa* Spreng.	Euphorbiaceae	Kasi	Uttar Pradesh	265	2	37·0	
29.	*Terminalia arjuna* (Roxb.) W. & A.	Combretaceae	Arjun	Bihar	102	1	42·0	
30.	*Dipterocarpus turbinatus* Gaertn. f.	Dipterocarpaceae	Teli Gurjan	Manipur	195	1	44·0	Ends severely damaged
31.	*Lagerstroemia lanceolata* Wall.	Lythraceae	Benteak	Bombay	226	5	48·0	
32.	*Dalbergia sissoo* Roxb.	Leguminosae	Shisham	Punjab	266	6	49·0	
33.	*Anogeissus latifolia* Roxb.	Combretaceae	Axlewood	Tamil Nadu	Numerous	3	56·0	
34.	*Mesua ferrea* Linn.	Guttiferae	Masua or Ironwood	Mysore	-do-	2	57·0	

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36.	*Gmelina arborea* Linn.	Verbenaceae	Gamari	Bombay	-do-	4	58·0	
37.	*Careya arborea* Roxb.	Myrtaceae	Kumbhi	Tripura	-do-	Nil	58·0	
38.	*Diospyros melanoxylon* Roxb.	Ebenaceae	Ebony	Bombay	-do-	1	60·0	Three huge tunnels
39.	*Dillenia indica* Linn.	Dilleniaceae	Dillenia or Chalta	Assam	-do-	6	60·0	
40.	*Bombax ceiba* Linn. (=*Bombax malabaricum* DC.)	Bombacaceae	Semul	Dehra Dun	227	5	65·0	80% destruction in a panel from Kutch
41.	*Albizzia* sp.	Leguminosae		Madhya Pradesh	115	2	67·0	Twelve large tunnels
42.	*Albizzia odoratissima* Benth.	-do-	Kalasiris	Uttar Pradesh	89	3	68·0	Five huge tunnels
43.	*Michelia champaca* Linn.	Magnoliaceae	Champ	West Bengal	Numerous	1	68·0	
44.	*Michelia doltsopa* Bush. Ham. ex DC. (=*Michelia excelsa* Blume)	-do-	Champ	-do-	220	2	68·0	
45.	*Syzygium cumini* (L.) Skeels (=*Eugenia jambolana* Lam.)	Myrtaceae	Jamun	Madhya Pradesh	Numerous	3	70·0	
46.	*Dysoxylum malabaricum* Bedd.	Meliaceae	White cedar	Tamil Nadu	Numerous	4	70·0	
47.	*Cynometra polyandra* Roxb.	Leguminosae	Ping	Assam	194	8	70·0	
48.	*Castanopsis hystrix* A.DC.	Cupuliferae	Hingori	-do-	187	3	72·0	
49.	*Shorea robusta* Gaertn. f.	Dipterocarpaceae	Sal	Vindhya Pradesh	260	3	72·0	
50.	*Casuarina equisetifolia* Forst.	Casuarinaceae	Casuarina	Bombay	Numerous	2	75·0	

51.	*Chukrasia velutina* Wt. & Arn. (=*Chukrasia tabularis* A. Juss.)	Meliaceae	Chickrassy	Mysore	Numerous	3	75·0	
52.	*Cryptomeria japonica* D.Don	Taxodiaceae	Suji	West Bengal	-do-	Nil	75·0	
53.	*Palaquium ellipticum* (Dalz.) Engler. (=*Dichopsis elliptica* Bth.)	Sapotaceae	Pali	Mysore	-do-	5	78·0	
54.	*Grewia tilaefolia* Vahl	Tiliaceae	Dhaman	Tamil Nadu	290	4	80·0	
55.	*Zanthoxylum limonella* (Dennst.) Alston.	Rutaceae	Mullilam	Kerala	Numerous	Nil	80·0	
56.	*Soymida febrifuga* A. Juss.	Meliaceae	Rohini	Bombay	239	4	80·0	
57.	*Mimusops* sp.	Sapotaceae		Andaman	Numerous	5	80·0	
58.	*Ougeinia oojeinensis* (Roxb.) Hochreut (=*Ougeinia dalbergioides* Benth.)	Leguminosae	Sandan	Uttar Pradesh	-do-	1	80·0	
59.	*Albizzia chinensis* (Osbeck) Merr. (=*Albizzia stipulata* Boiv.)	-do-	Siris	Andhra Pradesh	-do-	Nil	80·0	Seven huge tunnels
60.	*Mangifera indica* Linn.	Anacardiaceae	Mango	Assam	-do-	4	85·0	
61.	*Pinus roxburghii* Sargent (=*Pinus longifolia* Roxb.)	Coniferae	Chir	Kashmir	Numerous	4	85·0	95% destruction in a panel from Dehra Dun
62.	*Exbucklandia populnea* (R. Br. ex Griffith) R.W. Brown (=*Bucklandia populnea* R.Br.)	Hamamelideae	Pipli	West Bengal	-do-	1	90·0	
63.	*Cedrus deodara* (Roxb. ex Lambert) G. Don	Coniferae	Deodar	Kashmir	-do-	Nil	90·0	
64.	*Machilus macrantha* Nees	Lauraceae	Machilus	Kerala	-do-	1	92·0	
65.	*Polyalthia fragrans* (Dalz.) Bedd.	Anonaceae	Gauri	Coorg	-do-	3	92·0	
66.	*Picea smithiana* (Wall.) Boiss (=*Picea morinda* Link).	Coniferae	Spruce	Himachal Pradesh	-do-	6	94·0	
67.	*Vateria indica* Linn.	Dipterocarpaceae	Vellapine	Kerala	-do-	Nil	95·0	
68.	*Sonneratia apetala* Ham.	Lythraceae	Keora	West Bengal	-do-	Nil	96·0	
69.	*Salmalia insignis* (Wall.) Schott & Endl. (=*Bombax insigne* Wall.)	Bombacaceae	Semul	Andaman	-do-	2	97·0	

The species are arranged in the order of decreasing resistance to borers.

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66.	*Picea smithiana* (Wall.) Boiss (=*Picea morinda* Link).	Coniferae	Spruce	Himachal Pradesh	-do-	6	94·0	
67.	*Vateria indica* Linn.	Dipterocarpaceae	Vellapine	Kerala	-do-	Nil	95·0	
68.	*Sonneratia apetala* Ham.	Lythraceae	Keora	West Bengal	-do-	Nil	96·0	
69.	*Salmalia insignis* (Wall.) Schott & Endl. (=*Bombax insigne* Wall.)	Bombacaceae	Semul	Andaman	-do-	2	97·0	

The species are arranged in the order of decreasing resistance to borers.

the other hand, species like *Albizzia odoratissima* Benth, *Castanopsis hystrix* A.DC., *Cynometra polyandra* Roxb. and *Albizzia* spp. have less than 200 borers, whereas their damage was found to be 68%, 72%, 70% and 67% respectively. In the case of *A. odoratissima*, 92 borers accomplished 68% destruction. The larvae of shipworms show no special attraction to any timber and their settlement on a timber substratum is only accidental and influenced by the fouling accumulation. Hence it is possible that a test panel receives a large number of larvae, but the number of successful borers and their depth of penetration depend on the natural durability of that particular species of timber. In many cases, like *Terminalia chebula* Retz. and *Tectona grandis* Linn. f. only a few superficial tunnels were noticed and the holes were mere pits indicating unsuccessful penetration resulting in low percentage destruction compared to the number of entry holes. The number of borer holes as a criterion for grouping the results has been used by many workers (Purushotham & Santhakumaran 1962), but such expressions do not offer any satisfactory means for comparative studies. Splitting open the panel and assessing the internal damage by visual examination are essential for this purpose. If continuation of the test is needed, X-ray photography can be used.

4. The incidence of *M. striata* appears somewhat higher on panels comparatively unmolested by shipworms (Table 3). In most of the resistant panels, the destruction is mainly caused by large specimens of *M. striata* and the shipworms are present either as numerous pits or as a few superficial tunnels. Similar behaviour has been noticed by Edmondson (1955). Moore (1947) noted that no timber is naturally resistant to *Martesia* attack, although it may resist teredinids and crustacean borers. Spoon *et al.* (1946) also state that *Martesia* is capable of attacking hard woods.

5. Of the twenty-one species which were found to possess some degree of resistance to borer attack, many like *Kingiodendron pinnatum* (Roxb.) Harms. (=*Hardwickia binata* Roxb.), *Steriospermum chelonoides* DC., *Borassus flabellifer* Linn., *Schleichera oleosa* Oken. (=*S. trijuga* Willd.), *Artocarpus lakoocha* Roxb. and *Holoptelea integrifolia* Planch. are not presently used in marine constructions (Appendix 4, *Journal of the Timber Dryers' and Preservers' Association of India*, 7(2), 1961). It may be mentioned in this connection that *K. pinnatum* (=*Hardwickia binata* Roxb.) is sometimes used as a substitute for teak, in planking for cargo barges built at Kakinada (Paul B. Zeiner & Kjeld Rasmussen 1958). It, however, cracks when cut into thin planks and in spite of its durability, this might restrict its use in fishing vessels. Timber species most commonly used at present for marine construction generally belong to the largely non-resistant varieties. The present studies indicate the possibility of substituting these non-durable species with better timber